

REFERENCE TO RELATED APPLICATION

BACKGROUND OF THE INVENTION

Conventional computers, such as desktop computers, typically include a visual display screen, such as a cathode ray tube(CRT). Conventional computers also typically include a user input pointing device, such as a mouse. The mouse typically includes a ball and position encoders. As the user moves the mouse over a work surface, the ball rotates and the position encoders provide position information to the computer. The position information is indicative of the movement of the mouse. Based on the position information, the computer system typically moves a mouse cursor about the visual display screen allowing the user to acquire targets on the visual display screen.

A conventional mouse also typically includes one or more actuator buttons. The actuator buttons are typically actuable by the operator by simply depressing the selected button. Actuation of the buttons can implement a number of different features. For example, where the user has acquired a target (e.g., an icon), by placing the mouse cursor over the

icon on the visual display screen, the user may typically be able to select the feature or program represented by that icon by simply depressing one of the actuator buttons after the target has been
5 acquired.

In one conventional system, the cursor is associated with an arrow, or other visible display element which moves about the screen. The cursor display element or display image is conventionally
10 treated the same as any other object on the display screen, from a depth perception standpoint. Therefore, when the display screen is displaying a large number of icons, windows, or other display elements, the cursor can be difficult to locate and
15 follow during operation.

SUMMARY OF THE INVENTION

A system and method display in ancillary image which is movable with a cursor image. A cursor image indication is obtained which is indicative of the
20 cursor image. An ancillary image indication is generated based on the cursor image indication. The cursor image and the ancillary image are displayed based on the cursor image indication and the ancillary image indication.

In one illustrative embodiment, the ancillary image is a shadow cast by the cursor image. Therefore, while the cursor image is opaque, the ancillary image is translucent. Of course, the ancillary image can take any other of a wide variety
25 of forms, some of which are discussed below. However, the ancillary image is movable along with the cursor during operation.
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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an exemplary environment for implementing the present invention.

FIG. 2 illustrates a cursor image with an ancillary image in accordance with one embodiment of the present invention.

FIG. 3 is a flow diagram illustrating creation and display of the ancillary image in accordance with one embodiment of the present invention.

FIG. 4A is a flow diagram illustrating creation of an ancillary image in greater detail in accordance with one embodiment of the present invention.

FIGS. 4B-4D illustrate the creation of an ancillary image as described with respect to FIG. 4A in accordance with one embodiment of the present invention.

FIG. 5A is a flow diagram illustrating creation of an ancillary image in greater detail in accordance with one embodiment of the present invention.

FIGS. 5B and 5C illustrate the creation of the ancillary image as described with respect to FIG. 5A.

FIG. 6A is a flow diagram illustrating the creation of an ALPHA-mask and SHADOW-mask in accordance with one embodiment of the present invention.

FIG. 6B illustrates the creation of the ALPHA and SHADOW-masks as described with respect to FIG. 6A.

FIG. 7 is a flow diagram illustrating the
blending of a cursor image and an ancillary image to a
30 display screen.

FIGS. 8A-8C illustrate alternate embodiments of ancillary images in accordance with further aspects of

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With reference to FIG. 1, an exemplary environment for the invention includes a general purpose computing device in the form of a conventional personal computer 20, including processing unit 21, a system memory 22, and a system bus 23 that couples various system components including the system memory to the processing unit 21. The system bus 23 may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory includes read only memory (ROM) 24 a random access memory (RAM) 25. A basic input/output 26 (BIOS), containing the basic routine that helps to transfer information between elements within the personal computer 20, such as during start-up, is stored in ROM 24. The personal computer 20 further includes a hard disk drive 27 for reading from and writing to a hard disk (not shown), a magnetic disk drive 28 for reading from or writing to removable magnetic disk 29, and an optical disk drive 30 for reading from or writing to a removable optical disk 31 such as a CD ROM or other optical media. The hard disk drive 27, magnetic disk drive 28, and optical disk drive 30 are connected to the system bus 23 by a hard disk drive interface 32, magnetic disk drive interface 33, and an optical drive interface 34, respectively. The drives and the associated computer-readable media provide nonvolatile storage of computer-readable instructions, data structures, program

modules and other data for the personal computer 20.

Although the exemplary environment described herein employs a hard disk, a removable magnetic disk 29 and a removable optical disk 31, it should be appreciated by those skilled in the art that other types of computer readable media which can store data that is accessible by a computer, such as magnetic cassettes, flash memory cards, digital video disks, Bernoulli cartridges, random access memory (RAM), read only memory (ROM), and the like, may also be used in the exemplary operating environment.

A number of program modules may be stored on the hard disk, magnetic disk 29, optical disk 31, ROM 24 or RAM 25, including an operating system 35, one or more application programs 36, other program modules 37, and program data 38. A user may enter commands and information into the personal computer 20 through input devices such as a keyboard 40 and pointing device (or mouse) 42. Other input devices (not shown) may include a touch pad, roller ball, microphone, joystick, game pad, satellite dish, scanner, or the like. These and other input devices are often connected to the processing unit 21 through one of a plurality of ports. For instance, keyboard 40 is connected through a keyboard port 45, and mouse 42 is connected through serial port interface 46 but could also be connected through a MousePort or a PS/2 port.

In the illustrative embodiment, keyboard port 45 and serial port interface 46 are coupled to the system bus 23. User input devices may also be connected by other interfaces, such as a sound card, a parallel port, a game port or a universal serial bus (USB). A monitor

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47 or other type of display device is also connected to the system bus 23 via an interface, such as a video adapter 48 controlled by a graphics engine either integrated with or located separately from operating system 35. Of course, the display can be provided on a CRT or any other type of display device, such as plasma display, an LED or LCD device, as examples. In addition to the monitor 47, personal computers may typically include other peripheral output devices such as a speaker and printers (not shown).

The personal computer 20 may operate in a networked environment using logic connections to one or more remote computers, such as a remote computer 49. The remote computer 49 may be another personal computer, a server, a router, a network PC, a peer device or other network node, and typically includes many or all of the elements described above relative to the personal computer 20, although only a memory storage device 50 has been illustrated in FIG. 1. The logic connections depicted in FIG. 1 include a local area network (LAN) 51 and a wide area network (WAN) 52. Such networking environments are commonplace in offices, enterprise-wide computer network intranets and the Internet.

When used in a LAN networking environment, the personal computer 20 is connected to the local area network 51 through a network interface or adapter 53. When used in a WAN networking environment, the personal computer 20 typically includes a modem 54 or other means for establishing communications over the wide area network 52, such as the Internet. The modem 54, which may be internal or external, is connected to

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Cursor image 202 also illustrates an ancillary image 206. In the embodiment illustrated in FIG. 2,

FIG. 3 is a flow diagram illustrating one embodiment of the formation and display of the ancillary image 206 along with opaque portion 204 of cursor image 202. It should again be noted that creation of an alpha blended ARGB bitmap cursor image can be directly specified by an application and need not have an ancillary image per se, but simply be a composite image incorporating per pixel alpha and color values. FIG. 3 describes but one embodiment of generation of an ARGB bitmap cursor image, and also includes an ancillary image which is based on the cursor image.

First, an indication of the cursor image is
30 obtained. This is indicated by block 212 in FIG. 3.
The image of the cursor can be a bitmap or other
similar indication which illustrates cursor image 202.

FIG. 4A illustrates the creation and display of an ancillary image in greater detail. FIGS. 4B-4D illustrate portions of cursor image 200 during the creation and display of the ancillary image 206 and opaque portion 204.

Most cursor images 202 have an associated AND-mask. The AND-mask is a monochrome bitmap of the same dimensions as the bitmap defining the cursor image. In the associated AND-mask, each bit defines whether the corresponding pixel in the cursor image is visible or non-visible. For example, FIG. 4B illustrates an AND-mask 220 for the cursor image 202 shown in FIG. 2. The bits within arrow 222 (which corresponds to the opaque portion 204 of cursor image 202) are given a value of zero, which means those pixels are visible. The bits residing within AND-mask 220, but outside of arrow 222 (i.e., which correspond to the invisible pixels of cursor image 202 - ignoring the ancillary image 206 for now) are given a value of 1 which indicate that the corresponding pixels are invisible. In any case, the cursor AND-mask is first obtained. This is indicated by block 224 in FIG. 4A.

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In addition, when the ancillary image is a shadow, it must be offset from the primary image of the cursor. Of course, the offset value can be predetermined or dynamically variable. Therefore, when the cursor AND-mask is expanded to the 32 bit per pixel bitmap, the pixels are positioned within the expanded bitmap, shifted by a desired vertical and horizontal offset value. FIG. 6B illustrates the original AND-mask 300 for a cursor image which is expanded into the ALPHA-mask 302. It can be seen that, in the embodiment illustrated in FIG. 6B, the ALPHA-mask is formed by providing an extra border around the AND-mask, and shifting the AND-mask downwardly and to the right, within the ALPHA-mask 302. Obtaining an offset value is indicated by block 306 in FIG. 6A, and shifting the translated AND-mask image by the offset value to relocate the ancillary image to a desired position (i.e., to obtain the ALPHA-mask) is illustrated by block 308 in FIG. 6A.

25 Once the SHADOW-mask has been obtained, the
cursor image and the SHADOW-mask can be blended to the
computer display in one of a wide variety of different
ways. In one illustrative embodiment, an alpha
blending function is performed using an application
30 programming interface (API) known as the AlphaBlend
supported by the WIN32 API set provided by Microsoft
Corporation of Redmond, Washington. Many different

types of alpha compositing operations can be performed to accomplish this. However, in one illustrative embodiment, a simple "source over" operation is used. In this type of compositing operation, each resulting
5 pixel displayed is a function of a source, a current destination, and an alpha value associated with the source as follows:

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Result = (source * alpha) + (1-alpha) * destination
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where the source color is the color of the shadow
5 (e.g., black) and the destination is the image on the
computer screen which will reside under the image
being blended to the computer screen. The areas
outside of the shadow and cursor have an alpha value
of zero. Therefore, it can be seen from Equation 1
10 that the resulting pixels will be unmodified. The
umbra portion of the SHADOW-mask has the highest alpha
value, so those portions of the screen will have more
black blended into the resulting pixels. The areas
with an intermediate alpha value (the penumbras) will
15 have somewhat less black blended into the resulting
pixel values.

This source over function is applied to each of the color channels as follows:

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$$\text{Result}_r = (\text{source}_r * \alpha) + (1-\alpha) * \text{destination}_r$$

Equation 3

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25 Resultg = (sourceg * alpha) + (1-alpha) * destinationg
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Equation 4

$$\text{Result}_b = (\text{source}_b * \alpha) + (1-\alpha) * \text{destination}_b$$

Subscript r designates the red channel, the subscript g designates the green channel and the

5 The term BitBlt refers to a function which transfers pixels from a specified source rectangle to a specified destination rectangle, altering the pixels according to a selected raster operation code. The supported raster operation codes include the SRCAND
10 code which combines the colors of the source and destination rectangles by using the BOOLEAN AND operator. The SRCPAINT code combines the colors of the source and destination rectangles using the BOOLEAN OR operator.

With this background, FIG. 7 can now be discussed. While FIG. 7 proceeds with respect to the above-described functions and APIs, it will be appreciated that this is for illustrative purposes only, and any other desired mechanism can be used to generate a composite image. Once the SHADOW-mask has been created as described above with respect to FIG.

25 6A, the graphics engine performs an SRCAND function of
the cursor AND-mask into the SHADOW-mask. The palette
is set so that the AND-mask pixel values of zero are
treated as the color transparent black (the (alpha,
red, green, blue) values are (0.0, 0.0, 0.0, 0.0)) and
30 the pixel values of one are treated as the color
opaque white (the alpha, red, green, blue) values are
(1.0, 1.0, 1.0, 1.0)). This combines the SHADOW-mask

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will be offset downwardly and to the right of the
cursor image. Of course, there need not be any visual
display of the simulated point light source. This
source is simply simulated based on how the shadow is
5 cast.

Other embodiments are contemplated as well. For
example, rather than having a fixed point light
source, the point light source can emulate the sun,
and can thus move from east to west (e.g., right to
10 left) across the screen based on the time of day. In
that case, the position of the shadow will change
depending on the current position of the point light
source and the current position of the cursor relative
to the point light source. Also, of course, rather
15 than being located at a central top region, the light
source can be located at substantially any position on
or off the screen such that the shadow will move about
the cursor image based on its position relative to the
point light source.

20 FIG. 8B illustrates yet another illustrative
embodiment of the present invention. FIG. 8B
illustrates the cursor placed at position 408 with
respect to a display screen that is also displaying a
window or icon 410. When the cursor is moved over the
25 window or icon 410, the ancillary image (in the
embodiment in which it is a shadow) is cast in the
normal fashion. However, when the user depresses a
mouse button (such as to acquire the target over which
it is drifting) the cursor moves in the direction
30 indicated by arrows 412. That is, in response to a
mouse click, a message hook procedure executes to move
the cursor image to where the shadow image had just

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been displayed. This has the appearance of the cursor moving downwardly onto the image over which it is traveling (and thus there is no shadowcast). Alternatively, for example, upon clicking the mouse button, the shadow can be replaced by a glow or halo rather than being eliminated.

FIG. 8C illustrates yet another illustrative embodiment of the present invention. It will be appreciated that windows, or icons, 414 illustrated in FIG. 8C can be layered over one another. In other words, the window in the foreground is displayed on top of the window in the background. Therefore, this gives the perception of depth within the display screen. In the illustrative embodiment shown in FIG. 8C, when the cursor is placed in position 416, it is over the window in the background. Since the cursor is always on the top of the display screen, this has the effect of the cursor being a relatively large distance away from the background window 414. Thus, the shadow or ancillary image is offset a relatively large distance from the cursor image. However, when the cursor is moved to position 418, it is positioned over the foreground window and is located closer to that window than the background window. In the embodiment illustrated in FIG. 8C, the ancillary image is thus offset by a smaller distance from the cursor image to give the appearance that the shadow is cast on a surface which is closer to the cursor image than the background window was. The depth information can be obtained from the data structure associated with the image under the displayed position of the cursor image.

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Similarly, the ancillary image can be one which reflects a simulated property of the cursor. In other words, if the cursor is displayed to look like a water droplet, the ancillary image can be a wavy shadow or image which gives the appearance of light impinging on a surface after it has traveled through water. In the illustrative embodiment, the ancillary image simply moves with the cursor image and is based on some characteristic or property of the cursor image.

It can thus be seen that one illustrative embodiment of the present invention provides a cursor with a shadow. This can be accomplished in any number of ways, such as by simply displaying or rendering a cursor which includes a shadow as a part of its image, or by obtaining information indicative of the cursor image and deriving the shadow based on the cursor information. Similarly, when the cursor and shadow are separately obtained or derived, they can be separately rendered on the display, or rendered as a composite image.

Other illustrative embodiments of the present invention include methods, displays and apparatus 25 which provide cursor and associated ancillary images as ARGB bitmaps. The ancillary images can exhibit a wide variety of characteristics.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.